4—THE FAUNA OF THE ALGAL ZONE OF THE SWAN RIVER ESTUARY.

A PRELIMINARY SURVEY OF FRESHWATER BAY WITH NOTES ON THE CHIEF SPECIES.

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Read 14th March, 1944.

INTRODUCTION.

The primary aims of this investigation were, firstly to learn the nature of the fauna inhabiting the algae, and secondly to follow the seasonal change in this fauna. From the data gathered various other observations have been made, such as the species density and population density of various algal species.

Adequate ecological study requires a team of workers. A lone worker can hope only to make a general survey of the situation. Especially is this so when, besides collecting and the laborious and time-expending work of separation it is necessaray to identify species which are quite unfamiliar. As a result a number of species have only been identified as far as the genus, and some remain assigned only to the family. However, all those which can be described as dominant have been specifically identified except for an immature Gammarid which occurred at times.

Acknowledgment is due to Professor G. E. Nicholls and to Dr. A. G. Nicholls for advice on literature and aid in other ways; and to Miss A. M. Baird and Mr. G. G. Smith, of the Botany Department for aid in identification of the higher algae.

Collections were made somewhat irregularly, due either to the number of species requiring identification, or to other unavoidable circumstances.

PRELIMINARY SURVEY OF FRESHWATER BAY.

Physiography.

Accounts of the Swan River estuary have been given by Somerville (1919) and by Aurousseau and Budge (1921). It need only be added that the main area of investigation was situated in Freshwater Bay at the part marked "C" in the map given by Somerville (*op. cit.* p. 17). The rocky bottom under the high cliffs at this point provides an admirable substratum for the algae.

Physical Conditions.

The Swan estuary differs in type from those upon which a fairly abundant literature exists (Alexander 1936; Bassindale 1938; Milne 1940, etc.). Along the coast in this region there is practically no tide; as a result there is no daily alteration of fresh and salt water in the estuary, nor are there areas of mudflats daily exposed as is the case in tidal estuaries. There

is, however, a marked seasonal variation in salinity (Serventy 1938). In summer, conditions in the estuary are marine. In winter, the water is greatly diluted and after heavy rains becomes quite fresh at least in shallow water near the banks. This dilution is greatest during July and August.

During part of the year there is a regular daily rise and fall in the waters of the estuary, generally of about four to six inches. This appears to be due, not so much to tidal influence, but to the regular alternation of land and sea breezes. An easterly (land) breeze drives the waters of the adjacent ocean away from land, depressing the level of waters along the coast and consequently in the drowned valley of the estuary. A westerly (sea) breeze piles water against the coast and raises the water level. If the westerly continues for several days, as may happen during a storm, the level of water is raised several feet. Similarly when an easterly continues for an abnormal period, the water level may drop a few feet and as a result expose some of the algal beds which otherwise are not out of water.

The area under investigation is under direct illumination from the sun from early morning till late afternoon, when the high cliffs shut off the direct rays of the sun.

No measurements of temperature were taken, but, as was to be expected, in depths of only a few inches the water was considerably warmer than in deeper water, if there had been practically no water movement for some time and the sun was particularly hot.

The currents in the estuary are practically confined to the deeper channels. Shallow areas such as the one under consideration are more influenced by the surface drift produced by winds. Though normally inconsiderable, waves of up to two feet may be raised during strong winds, thus laying the shallows open to some battering.

There is always a considerable amount of organic matter and soil in the water, but usually the bottom can be seen at several feet depth. However, after heavy rains greatly increased quantities of material occur suspended in the water and it may be impossible to see the bottom even at a depth of 1 ft. 6in. Photosynthesis in the algal zone must be considerably impeded during such periods.

Algal Zone.

The rock bottom on which the algae occurs is a ledge of shallow depth along the bank, extending outwards for a width of 7ft. to 16ft. Most of the algae occurs from surface level to a depth of 5ft., though ocasionally patches were found at 7ft.

Methods.

The method of collection consisted simply of plucking the algae from the substratum and transferring to a collecting jar. In the case of larger algae, such as *Cystophyllum muricatum* it was sometimes necessary to cut off only part of the stem or only branches. At first the transference of material was made under water with a control jar of water to ascertain whether there was any free-swimming population to influence results. Later trials, however, showed that no significant loss occurred if the algae were lifted out of the water and then transferred. As this method was more rapid and more easily accomplished it was adopted.

Estimation of Population.

Although the importance of the algal fauna has long been recognised and such phrases as "among sea-weed" frequently occur in records, few studies of the fauna of aquatic vegetation have been made. Those that have been made are concerned almost entirely with fresh water plants (Ward, 1896; Moore, 1913; Richardson, 1921; Percival & Whitehead, 1929; Krecker, 1939), usually with flowering plants. Descriptions of the algal zones of the sea have rarely been accompanied by data as to the small members of the communities on and among the algae. The record is mostly of the dominant animals, usually Molluscs, occurring on the same substratum as the algae and sometimes passing on to the vegetation. (Flattely & Walton 1922; Colman, 1933; Kitching, 1935; Bright, 1938; Stephenson & Bright, 1938; Bokenham, 1938; Eyre, 1939; Stephenson & Day, 1940). A method for the quantitative analysis of the fauna of aquatic vegetation is wanting. Moore (1913) used the general terms "abundant" and "scarce." Bokenham (1938) used "Dominant," "Plentiful" and "Present." Richardson (1921) made a quantitative count of the upper nine inches of aquatic plants. The count was based on the animals washed off the plants collected from a definite area. Other workers (Needham, 1928, 1929; Pate, 1932) have failed to differentiate between the animals of the plants and those of the underlying substratum, except in the case of the two authors mentioned next.

Krecker (1939) working on fresh-water phanerogams took as a basis the population per ten linear feet of plant. He conducted a plant to plant examination. The only alga investigated in the Swan estuary which lends itself to such treatment is *Cystophyllum muricatum,* which attains lengths of up to seven feet. But the majority of the algae are relatively short, occurring as more or less branching filaments or intertwining strands densely crowded together. The broad flat *Ulva lactuca* provides a third type.

Colman (1940) working on the fauna of the intertidal sea-weeds, used the number of animals per unit weight of sea-weed. The method adopted in the present research was to calculate the fauna per 100 c.c. of the alga measured by displacement of water. As few, if any, of the animals present used the algae as food, but rather as a substratum it was considered that the space occupied by the alga was of more significance than the weight, since the volume bears a constant relationship to the surface of the plant (though admittedly the relationship varies to a degree from plant to plant according to irregularities of shape) whereas the weight is not a function of the surface, since it varies with the density. The displacement method adopted is also advantageous in being rapid.

By this means a picture was gained not only of the algal fauna as a whole, but enabled comparison between different algae.

ALGAE.

The dominant species of algae in the estuary are:—

Cystophyllum muricatum	*Enteromorpha compressa*
Chaetomorpha aera	*Ectocarpus confervoides*
Cladophora penicillata	*Ulva lactuca*

Besides these, others occur, usually as isolated clumps amongst the others and may sometimes have been included amongst collections. (For example. other species of *Enteromorpha* may have been included amongst *E. compressa.*) These secondary species include:—

Asperococcus sp.	*Chaetomorpha nitidula*
Calothamnium sp.	*Caulerpa cylindracea*
Enteromorpha prolifera.	*Gracilaria confervoides*
Enteromorpha intestinalis	*Monospora australis*
Enteromorpha claphrata	*Polysiphonia mollis*
Enteromorpha plumosa	*Zoobotrium pelucides*

Some of these are abundant elsewhere in the estuary (*G. confervoides*) but do not occur in quantity in the area investigated.

DIATOMS.

Some colonial diatoms were present on the algae throughout the year. Three periods of particular abundance were noted. These occurred in March, May and October. From the nature of their surfaces *Cystophyllum* and *Cladophora* provided the best substratum for these, while *Ulva* was practically free from diatoms. From May to late July diatoms were fairly abundant but were very scarce in August and September.

No identification was attempted beyond the genus. The following are the genera present at the three peak periods. Except from May to July the amount of diatoms rather rapidly fell away from the peak.

March.	May.	October.
Frustulia (*Navicula*)	*Coscinodiscus*	*Synedra*
Pleurosigma	*Rhizosolenia*	*Bacillaria*
Gammatophora	*Gammatophora*	*Melosira*
Lycmophora	*Melosira*	
Melosira	*Nitzschia*	
Striatella	*Lycmophora*	
Asterionella (?)		

The genera are listed in order of relative abundance. It is notable that the October increase was due almost entirely to *Synedra*. By November *Bacillaria* and *Melosira* had disappeared and *Coscinodiscus* was sparingly present.

FAUNA.

Here is given a list of the fauna as identified for the purpose of this investigation. Thus Gammarid spp. includes two or three species of which one representative only was found and cannot be regarded as a true member of the algal fauna.

Protozoa
- No record kept. Maximum abundance in April.

Hydrozoa
- *Campanularia verticillata* (?) (Linn).

Turbellaria
- *Leptoplana* spp.

Nemathelminthes
- *Nematoda* spp.

Polychaeta
- *Nereis oxypoda* Marenzeller
- *Nereis albanyensis* Augener
- *Ceratonereis erythraeensis* Fauvel.
- Small Nereids
- *Odontosyllis fulgarans* Claparede
- Spionid. sp.

Oligochaeta
- Microdrilids.

Polyzoa
- Polyzoan sp.

Tanaidacea
- *Tanais cavolinii* Milne-Edwards.
- *Paratanais* sp.

Harpacticoida
- *Ameira minor* Thompson & Scott.
- *Amphiascoides intermixtus* (Willey).
- *Amphiascopsis sexsetatus* (Monard).
- *Amphiascus* sp.
- *Dactylopusia tisboides* Claus
- *Ectinsosoma propinquum* T. & Scott.
- *Harpacticus gracilis* Claus
- *Idyella exigua* Sars
- *Mesamphiascus normani* (Sars)
- *Mesochra parva* J. M. Thomson
- *Parathalestris* sp.
- *Perissocope* sp. (?)
- *Pseudothalestris pygmaea* T. Scott.
- *Tegastes* sp.
- *Tisbe furcata* Baird
- *Tisbe graciloides* Sars
- *Tisbe tenera* Sars
- *Zaus* sp. (?)

Calanoidea
- *Gladioferens imparipes* J. M. Thomson.

Ostracoda
- *Xestolebris aurantia* Baird.
- *Cytherid* spp.

Isopoda
- *Cruranthura simplicia* J. M. Thomson.
- *Munna brevicornis* J. M. Thomson.

Amphipoda
- *Caprella penantis* Leach
- *Caprella scaura* Templeton
- *Corophium minor* J. M. Thomson
- *Corophium* sp.
- *Erichthonius pugnax* Dana
- Gammarid spp.
- *Melita* sp.
- *Pallasea* sp. (?)
- *Talorchestia* sp.

Caridea
- *Leander intermedius* Stimpson

Brachyura
- *Cyclograpsus audouinii* Milne Edwards.
- *Halicarcinus australis* (Haswell)

Arachnida
- *Litarachna* sp.

Insecta
- Chironomid (?) larvae

Mollusca
- *Modiolus* sp.
- *Rissoa* sp.

Ascidacea
- *Ascidea malaca* (Traust.)

Chaetognatha
- *Sagitta* sp.

Analysis of Collections.

Appended at the end of this paper is a table (Table 1) setting out the monthly mean results. The quantities are expressed, as explained under "Estimation of population," in terms of the number of animals per amount of algae displacing 100 c.c. of water. The total number of animals in any column then represents the population density per 100 c.c. for that type of algae.

From the table it is evident that no species of alga was present during all 10 months, although *Enteromorpha* was completely absent only in August. The following list shows the species of alga present from month to month and their relative abundance.

(a)—abundant; (b)—well distributed; (c)—isolated stands.

March—*Cystophyllum* (a), *Enteromorpha* (a), *Ulva* (b).

April—*Cystophyllum* (a), *Enteromorpha* (a).

May—*Cystophyllum* (a), *Enteromorpha* (a).

June—*Cystophyllum* (b), *Enteromorpha* (a), *Ulva* (a).

July—*Cystophyllum* (c), *Enteromorpha* (b), *Ulva* (a), *Chaetomorpha* (c).

August—*Ulva* (a), *Chaetomorpha* (b).

September—*Cystophyllum* (c), *Enteromorpha* (b), *Cladophora* (c).

October—*Enteromorpha* (c), *Cladophora* (c), *Ectocarpus* (a).

November—*Enteromorpha* (a), *Cladophora* (a), *Ectocarpus* (a).

December—*Enteromorpha* (c), *Cladophora* (a), *Ectocarpus* (c), *Ulva* (c).

Animal Distribution.

From March to September *Cystophyllum muricatum* provided the most favoured habitat for the algal fauna. From October to December *Ectocarpus confervoides* was favoured as long as it was thriving, but in December when it was decaying *Cladophora penicillata* became the chief habitat. *Ulva* at all times provided the least utilised substratum, being most densely inhabited in March when the fronds were of great size and much convoluted. There can be little doubt but that it is the character of the plant that causes the differences rather than environmental conditions. It is noticeable that *Cystophyllum muricatum*, *Cladophora penicillata* and *Ectocarpus confervoides* provided the best substrata for the colonial diatoms.

Seasonal Changes.

Almost assuredly associated with the change in salinity is the change in the species making up the algal communities. No species was recorded in all ten months. *Tanais cavolinii*, while absent only in October, was repre-

sented by immature specimens only during August, September and November. The following were the dominant species (numerically) from month to month:—

March—*Tanais cavolinii. Caprella penantis.*
April—*Caprella penantis; Tanais cavolinii.*
May—*Harpacticus gracilis.*
June.—*Erichthonius pugnax; Melita* sp. (Immature).
July—*Caprella scaura; Tanais cavolinii.*
August—*Gladiofercns imparipes.*
September—*Gladioferens imparipes.*
October—*Mesochra parva; Gladioferens imparipes.*
November—*Mesochra parva; Gladioferens imparipes.*
December.—*Harpacticus gracilis; Tisbe tenera.*

The population density of the algal zone fell from March to August and then rose again. (See text fig. 1.)

The number of species present also dropped from 33 in March to six in September, rising again to 25 in December.

Species Density.

Following Hesse, Allee, Schmidt (1937), "Species Density" is taken to mean the number of species present in unit area or unit volume. The figures are given at the bottom of Tables 1 and 2. It will be seen that although *Cystophyllum* had the greatest population density, in March and June its species density was not as great as that of *Enteromorpha,* and in April and May there was no significant difference between the two. The highest species density is 25, recorded for *Cladophora* in December. *Enteromorpha* follows with 22 in March. Like the population density, the species density fell from March to August and September and then rose again. The lowest species density recorded was 1 (*Ulva* in August, and *Enteromorpha* in September). Species density does not necessarily correspond with the population density. Thus in March *Cystophyllum* had the greatest population density, but the lowest species density.

Again, although two species of alga may have similar species densities, the species making up the community are not necessarily the same. Thus in July *Enteromorpha* and *Ulva* had species densities of 13 and 12 respectively but had only five species in common. The apparent preference for one alga or another is doubtless extremely complex in its causation; all the factors that influence environmental distribution probably play a part, food, competition with other species, vulnerability to attack and so on.

Variations with Depth.

Apart from the collections summarised in Table 1, on three occasions separate collections were made to gain an idea of distribution by depth. The results are shown in Table 2. The four inches nearest the surface are least densely inhabited, particularly where open to buffeting by the wind-driven waves. In positions sheltered by large rocks the top few inches are more thickly populated. Most species were taken between four inches and two

feet depth. But the population density varied in its maximum from deeper than two feet to shallower, probably according to the physical conditions at the particular time. A point to be noted is that in November, *Gladioferens imparipes* was present in large numbers below a depth of two feet, but absent entirely above; whereas *Mesochra parva* was present in large numbers in the surface layers, but few in numbers below two feet.

Biotic Influence from Outside the Community.

It has been mentioned earlier that certain of the species recorded in these collections are more properly regarded as only occasional intruders into the algal association. Such are Gammarid spp. *Cyclograpsus audouinii, Modiolus sp., Sagitta sp.* Besides these there are occasional intruders which are not recorded in collections but whose presence was noted. This group includes both aquatic and non-aquatic creatures.

Aquatic intruders.

Trochus sp. Abundant on rocks above and below water level, and occasionally found amongst the algae. Also on the rocks occur *Balanus nigrescens* and *Balanus amphitrite* which possibly influence the abundance of the algae. *Sphaeroma quoyana* with its attendant commensal *Iais pubescens* (var. *longistylis*) burrows into the sandstone which forms the substratum for the algae. Whether it has any influence on the algal fauna above is unknown. Similar remarks apply to various Gammarids, Polychaets and Turbellarians found on the rock, together with various Isopods.

Hippocampus tuberculatus Castelnau has been taken in this weed area. Dunker (1910) reports *Trachyrramphus brevicaudis* Castelnau from the Swan estuary also, and this species may also occur amongst the algae.

The blue Serrated Swimming crab *Scylla serrata* has also been observed amongst the algae. Swarms of little fish periodically appear, and these were particularly abundant during September-October. The common "jelly-fish," *Aurelia aurita* is sometimes driven in large numbers among the algae, with what effect, if any, upon the algal fauna is problematical.

Extra-aquatic intruders.

These generally appear when the water is particularly low, exposing the algal beds to the air. Some of the birds also pick through the weeds in shallow water. The following have been observed apparently feeding on or among the algae or the Molluscs on the rocks beneath.

Phalacrocorax atra.
Phalacrocorax varius.
Phalacrocorax carbo.
Microcarbo melanoleucus.
Pisobia minuta
Tringoides hypoleucus.
Larus novae-hollandiae.

When the algae are exposed, numbers of ants, flies, wasps, spiders, land isopods and beetles (e.g., *Ophodinus* sp.) make their way thither, retreating again as the water rises. Most of the algal fauna doubtless retreats as the water level falls, but some at least remain in the damp weed.

NOTES ON THE CHIEF SPECIES.

The notes presented below are mainly of an ecologic and systematic nature. No detailed account of any species is given.

Leptoplana spp.

A few specimens were definitely identified as *Leptoplana,* but it is possible that other genera are included under this heading. These animals were much more common on the rocky substratum, and occurred on the algae mostly when they were covered in diatoms and were in an old and semi-decaying state.

Ceratonereis erythraeensis Fauvel 1919 and *Nereis oxypoda* Marenzeller 1879.

Monro (1938) has recorded these species from the Swan estuary, and Augener (1913) named ? *Nereis* (*Ceratonereis*) *aequisetis* which Monro says may be the former species. These were the largest and most common of the nereids found on the algae.

Nereis albanyensis Augener 1913.

A few specimens were obtained in August. The species has been recorded by Augener from Albany and Fremantle. Except for an occasional small specimen, Nereids were absent from March to October.

Tanais cavolinii Milne-Edwards, 1828.

This is probably a cosmopolitan species. It has been recorded from the Atlantic Coast of North America, Bermuda, Greenland, West Coast of Norway, British Isles, Western France, Azores, Mediterranean. It usually occurs in shallow water (1ft. to 6ft.) among algae. It has also been recorded from oysters, on *Balanus,* on *Pinna,* and sponges.

T. cavolinii is tubicolous, though it leaves its tube quite regularly in search of food and crawls slowly over the algae. The tube is of mucin, to which little bits of algae and other detritus are joined. On several occasions Nematodes were found in the same tube. The tubes are usually twice as long as the animal, but may be smaller or larger.

Although as far as ascertained not previously recorded from the southern hemisphere, there is little doubt that the species recorded is *T. cavolinii.* It agrees perfectly with Sars' (1899) description of *tomentosus* (synonymy, see Dollfuss, 1897) and with Richardson's (1905) description.

The numbers of *T. cavolinii* were greatest in March, and the proportion of ovigerous females was also greatest at this time (33%). Numbers fell off rapidly till June, presumably as a result of the lowering of salinity. A temporary increase occurred in early June, ovigerous females being taken for the first time since the end of April. However, by the middle of July the species was again very scarce and was not recorded at all in October. No females were found from the middle of July to the beginning of September. The few specimens found in November were all immature.

There seems little doubt that optimum conditions in the estuary for *T. cavolinii* occur during the summer, probably before March. Males were more numerous than females from March through the winter, but females were present in greater numbers than the males in December.

Dactylopusia tisboides Claus 1863.

This species was never very common, but was taken in every sample from March to July. Distribution is very wide: recorded from Woods Hole, Franz Josef Land, Greenland, Coast of Norway, Kiel Bay, British Isles, France, Mediterranean, Red Sea, Kergnelen, Western Australia.

Ectinosoma propinquum T. and A. Scott, 1896.

Also not common but taken from March to June. Distribution: Scotland, Franz Josef Land, Coast of Norway, Ceylon.

Harpacticus gracilis Clans, 1863.

It is possible that some specimens attributed to this species are referable to another as each individual was not checked. But several times during the year a proportion of the specimens were examined and on each occasion proved to be *H. gracilis*. The limbs correspond perfectly in structure with the drawings of Monard (1928). Distribution includes the North Sea, Mediterranean, Black Sea, Chilka Lake, Snez Canal, Atlantic Coast of North America, Kerguelen.

The species was evidently decreasing in March, was poorly represented in April but underwent a huge increase in May to decrease in collections throughout June. It was absent from August to October. In November a few specimens occurred, but by December a tremendous increase had again taken place.

Mesochra parva J. M. Thomson.

This was recorded in sparing numbers throughout the year until October when it swarmed in the shallower waters, while *Gladioferens imparipes* was predominant rather deeper. A check of the collection has shown that while the October-November increase included only *M. parva* earlier in the year (March-June) a few of the specimens recorded as *M. parva* are referable to another species, and are tentatively assigned to *M. pygmaea* (Claus) with which they agree most closely. This latter was represented by only a few specimens among the total. No sign of *M. parva* was found in December, its place being taken, apparently, by *Harpacticus gracilis.*

It is noteworthy that the proportion of males to females was 1 : 1.6 in October but was only 1 : 6.8 in November. About 50% of the females were ovigerous.

Perissocope sp. (?) This is a very uncertain identification, being first made from Wilson's key (1932), but imperfectly confirmed.

Tisbe spp.

Three species of *Tisbe* were identified, none being particularly numerous except *T. tenera* in December. *T. tenera* Sars and *T. furcata* Baird (1850) were found and a third species somewhat questioningly identified as *T. graciloides* Sars. These latter corresponded fairly well with Sars' figures especially in the detail of the first antennae.

The three species were present in greatest numbers in December. Their numbers during the rest of the year were low, though in July they were among the more conspicuous members of the fauna, since all species had either disappeared or were present in small numbers. Ovigerous females and immature specimens were common in December.

Distribution:—*T. tenera*: coast of Norway, English Channel, Roscoff, Suez Canal, Nicobar Is.

T. furcata: Alaska, New Zealand, Pacific Islands, Ceylon, Chilka Lake, Red Sea, Mediterranean, North Atlantic, Baltic, Nicobar Is., Maldive Is.

T. graciloides: West coast of Norway.

Gladioferens imparipes J. M. Thomson.

The genus is a southern hemisphere one closely related to *Boekella*. Its recorded distribution is from Western Australia through South Australia and New South Wales to New Zealand, generally in brackish waters.

G. imparipes first appeared in July when the river was becoming fresh, and slowly increased in numbers to become a dominant form in August, and reached its greatest numbers at the beginning of November, though at this time it was no longer found in the shallowest water as formerly but only amongst the algae at depths greater than 2 feet. By December only a few specimens remained.

Males and females were present in approximately equal numbers till the November increase, when females were more than twice as abundant as males. The proportion of ovigerous females was rather steady at about ¼ of the total.

Xestolebris aurantia Baird 1850.

The peculiarities of this genus left little doubt as to the generic identity of this form. On the basis of its close agreement with Sars (1921) description of *aurantia* it has been assigned to that species. Distribution: The British Isles, Holland, Baltic, Norway.

Cruranthura simplicia J. M. Thomson.

This was taken in few numbers in June, July and September, on each occasion on *Cystophyllum* only.

Munna brevicornis J. M. Thomson.

Taken in July, October, November and December. Numbers were small, but several ovigerous females were taken, together with males and immature specimens.

Caprella penantis Leach 1814 and *Caprella scaura* Templeton 1836.

These two forms were common among the algae and have been recorded together in the Tables as *Caprella* spp. Their variability with growth and sexual maturity was so great that identification was difficult. From March to May *C. penantis* formed the greater proportion of the catch. Those caught in July were entirely *C. scaura*.

Mayer (1912) in *Fauna Sudwest-Australiens* records *Metaprotonovae-hollandiae, Monoliopus agilis* and *Caprella aequilibra* also from the Swan river. No adult specimens of these species were taken. It is possible however that the young of *C. aequilibra* are included amongst the recorded immature forms, since the young of *C. scaura* and *C. penantis* develop to a considerable size before the frontal spine and other armature appears.

The Caprellids were among the dominant members of the fauna during March and April. Their numbers were reduced by the end of May, and they were present in but few numbers in June. They experienced a temporary increase in July and then disappeared. Despite the onset of summer conditions they had not reappeared in collections by 12th of December.

Distribution:—*C. penantis* (*C. acutifrons*) has been recorded from Geraldton and the Swan River, W.A., South Australia, New South Wales, Mediterranean and North Sea.

C. scaura from the Swan and at Bunbury, W.A., South Australia, New South Wales, Mediterranean, Rio de Janeiro, Mauritius, Japan, California.

Corophium minor J. M. Thomson.

It was taken from March to July, and then reappeared in November. It was taken in greatest numbers in late March. In December another larger species of *Corophium* was taken. It has not been identified and is recorded here as *Corophium* sp.

Erichthonius pugnax Dana 1852.

Chilton (1922) and others have considered that this and other recorded species of *Erichthonius* are to be referred to one species *E. brasiliensis* as different growth stages. However all the specimens collected which ranged from immature forms to ovigerous females and larger males were in close agreement with descriptions of *E. pugnax*. One large male seemed more in accord with *E. macrodactylus*.

The species is tubicolous, inhabiting tubes built on the algae. These tubes are very similar to those of *Tanais cavolinii* but with a greater proportion of sand utilised. The species was found only during June and July, but during the former month was one of the dominant species, at least as far as numbers are concerned. As far as I can ascertain this is the first record of the genus from Australia.

Distribution:—New Zealand, Sooloo Sea.

Melita sp.

Practically all the specimens recorded under this heading are immature specimens. However unless a great change occurs in proportion of parts such as the very short inner ramus of the third uropod and other character-

istics there can be little doubt that it is a *Melita*.. The generic distinctions are in agreement with those given for *Melita* by Stebbing (1906) and by Barnard (1941).

Leander intermedius Stimpson, 1860.

Serventy (1938) states that he found *Palaemonetes australis,* Dakin (1915) only, in the Swan estuary. I am not aware whether any of his specimens came from Freshwater Bay, but he does mention taking some in Crawley Bay, some way upstream. The nature of Crawley Bay differs from that of the area investigated in being predominantly sandy with scattered pieces of rock and continuing out as a shallow shelf much further than is the case in Freshwater Bay. All the specimens taken amongst the algae were *Leander intermedius.* Each specimen was dissected to make certain. In each case the mandible bore a distinct large palp, the absence of which distinguishes *Palaemonetes* from *Leander.* Besides those recorded in Table 1 extra specimens were taken from the algal area. (Kemp (1925) gives an excellent key and descriptions.) All proved to be *L. intermedius;* the specific characters were definitely those of intermedius, not of the marine *serenus.*

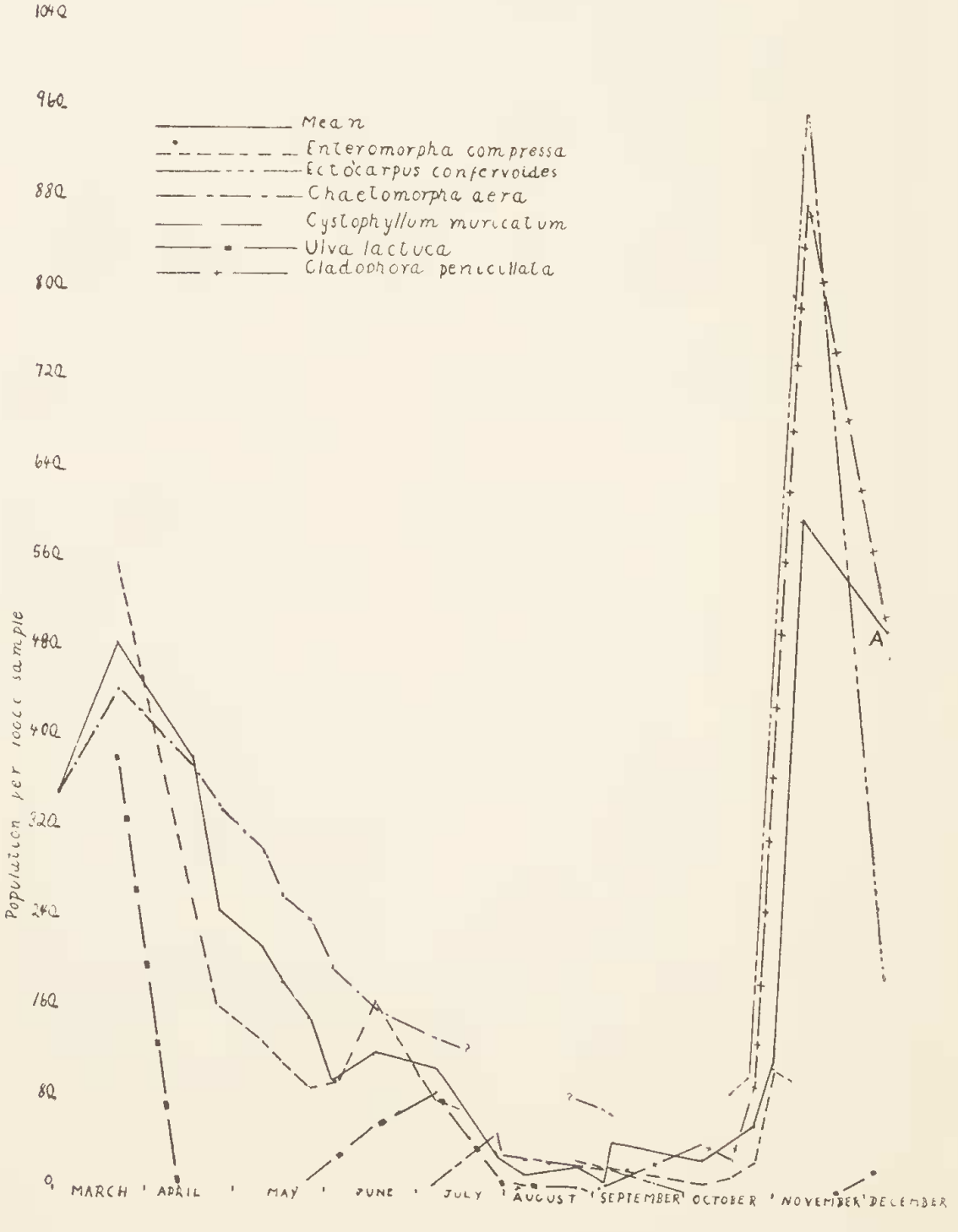
It was noted that a shrimp occurred on the shallow sandy portion of the bay just down-stream from the rock-algae area. Specimens of these were taken, and proved to lack a palp to the mandible and were identified as *Palaemonetes australis.*

It seems then that both these shrimps occnr in the estuary in different habitats, *L. intermedius* among the algae, and *P. australis* in the sandy shallows. Distribution: South Australia, Tasmania, Cockburn Sonnd.

SUMMARY.

The fauna occurring in six species of algae was investigated. The species of algae varied in abundance and none was present in all ten months of the survey. Some 52 species of animals were recorded as members of the algal community. These occurred in varying abundance at different times of the year. The maximum number of species occurring in any month was 33, the minimum six. Population density and species density are shown for each species of alga. Population density, species density, amount of diatoms present, and abundance of algae were all lowest in August-September. The dominant species in each month are listed. The nature of the species present changed as the salinity dropped during heavy winter rains. As summer returned the summer members of the fauna returned with the increasing salinity, *Caprella* spp. being the only species common in late summer collections which had not returned by December. It was found that the top four inches or so of the algae were not favoured, but most species were taken between four inches and two feet. A list of occasional intruders into the algal community is given. Added are ecologic and systematic notes on the chief species. A graph (text fig. 1) summarises the variation in population density. Besides the figures for each species of alga an estimated mean is given which is the average reading of the different algae present at the time, their relative abnndance being ignored except at the point A. The reading at this point represents the figure for *Cladophora pencillata* only since this was in vast abundance, whereas the other species recorded at this time were present in extremely small widely-scattered clumps. The reading for *Cladophora* thus gives a mnch more accurate picture of the algal fauna.

It will be noticed that two crops of *Ulva lactuca* occur during the year. *Cystophyllum muricatum* was not collected in August, and in September only a small specimen was found, after which none occurred. The dates of appearance and disappearance of other algae can be seen from the graph. A tremendous increase in animal population is indicated in November. It can be seen from the graph that the summer population is several times greater than that in mid-winter.



Text fig 1 : Variation in population density. March-December, 1943.

TABLE 1.

MONTHLY VARIATION IN POPULATION & SPECIES DENSITY FOR EACH ALGA.

SPECIES.	*Cystophyllum muricatum.*							*Enteromorpha compressa.*										*Ulva lactuca.*					*Chaetomorpha aera.*		*Cladophora penicillata.*				*Ectocarpus confervoides.*		
	March.	April.	May.	June.	July.	August.	September.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	March.	June.	July.	August.	December.	July.	August.	September.	October.	November.	December.	October.	November.	December.
Campanularia penicillata	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Leptoplana spp.	18	8	12	2	....	....	....	1	2	....	....	....	....	....	....	....	....	....	3	1	....	....	....	....	....	....	....	....	....	....	....
Nematoda spp.	....	....	10	2	10	....	....	22	....	12	1	....	....	....	....	....	....	9	2	....	....	....	....	....	....	....	2	....	....	....	....
Ceratonereis erythraeensis	18	4	....	11	....	....	11	24	....	....	....	....	....	....	....	....	....	5	1	....	....	....	....	....	....	....	24	....	3	....	....
Nereis oxypoda	10	....	....	....	....	....	....	14	....	....	....	....	....	....	....	8	....	....	....	....	....	....	....	....	....	3	8	....	5	....	....
Nereis albanyensis	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2	....	....	....	....	....	....	....
Small Nereids	....	....	....	....	2	....	....	6	....	....	2	....	....	....	....	....	....	....	3	....	....	....	2	1	....	....	34	2	8	....	....
Hesione sp.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....
Odontosyllis fulgarans	....	....	....	....	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....
Spionid sp.	....	2	....	....	....	....	....	....	....	....	....	....	....	....	2	....	....	....	....	....	....	....	....	2	....	....	....	....	....	....	....
Autolytus sp.	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Microdrilids	....	....	....	2	....	....	....	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Polyzoa sp.	....	....	4	30	....	....	....	....	....	....	3	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....
Ameira minor	2	4	....	3	....	....	....	2	1	....	3	....	....	....	....	....	....	9	2	....	....	....	....	....	....	6	....	....	....	....	....
Amphiascoides intermixtus	....	....	6	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Amphiascopsis sexsetatus	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Amphiascus sp.	....	....	....	....	....	....	....	20	....	....	....	....	....	....	....	....	....	8	....	....	....	....	....	....	....	....	1	....	....	....	....
Dactylopusia tisboides	4	....	16	....	5	....	....	18	4	1	9	....	....	....	....	....	....	2	....	3	....	....	....	....	....	....	....	....	....	....	....
Edinosoma propinquum	8	....	4	5	....	....	....	....	....	1	8	3	....	....	....	....	....	2	4	....	....	....	14	....	....	....	....	....	....	....	....
Harpacticus gracilis	93	6	108	7	5	....	....	16	4	29	35	....	....	....	....	8	40	51	....	3	....	....	4	....	....	....	2	140	....	2	120
Idyella exigua	....	....	....	....	....	....	....	....	....	....	6	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....
Mesamphiuscus normani	....	....	....	....	....	....	....	....	....	....	1	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Mesochra parva	....	....	5	....	4	....	....	24	....	....	....	....	....	....	16	72	....	1	....	1	....	....	....	4	3	57	836	....	76	623	....
Parathalestris sp.	....	....	....	3	....	....	....	....	....	....	....	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Perissocope sp.	....	....	11	....	....	....	....	....	....	4	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Pseudothalestris pygmaea	....	....	....	....	....	....	....	....	....	4	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Tegastes sp.	....	....	....	....	....	....	....	....	....	3	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....
Tisbe furcata	....	....	....	....	....	....	....	....	....	....	2	3	....	....	....	....	10	1	....	27	....	8	....	....	....	....	20	....	....	....	....
Tisbe gracilioides	....	....	....	....	....	....	....	....	....	....	1	7	....	....	....	....	....	2	....	17	....	....	....	....	....	....	....	....	....	....	....
Tisbe tenera	....	....	2	....	3	....	....	6	....	....	7	18	....	....	....	....	....	1	....	....	....	18	....	....	....	....	83	....	....	10	....
Tisbe sp. (Immature)	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	127	....	....	....	....
Zaus sp. ?	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....
Harpacticoids(Immature)	....	....	....	....	....	....	....	....	....	....	9	....	....	....	....	....	....	....	....	....	....	....	....	....	2	1	....	....	....	....	....
Gladioferens imparipes	....	....	....	....	2	....	74	....	....	....	....	6	....	20	1	....	....	....	....	1	....	....	....	16	9	1	....	2	32	298	....
Copepod nauplii	....	....	....	....	....	....	....	....	....	....	....	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Xestolebris aurantia	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	16	....	....	....	....	....	....	....	....	....	1	1	1	....	3	....
Cytherid sp.	....	....	....	....	....	....	....	....	....	....	2	3	....	....	1	....	....	1	....	....	....	....	....	....	....	4	5	4	1	....	....
Cirriped nauplii	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Tanais carolinii	246	102	4	17	41	....	14	52	43	26	5	1	....	....	....	....	....	18	4	3	....	....	....	6	....	....	2	9	....	....	22
Paratanais sp.	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Cruranthura simplicia	....	....	....	4	4	....	4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Munna brevicornis	....	....	....	....	....	....	....	....	....	....	....	3	....	....	2	....	....	....	....	....	....	....	....	....	....	11	7	....	....	2	....
Caprella spp.	6	242	2	9	50	....	....	124	93	18	1	....	....	....	....	....	....	74	....	....	....	....	16	....	....	....	....	....	....	....	....
Corophium minor	23	....	....	3	3	....	....	2	5	8	....	....	....	....	....	....	....	10	....	....	....	....	....	....	....	....	6	....	....	4	....
Corophium sp.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	4	....	....	....	....
Erichthonius pugnax	....	....	....	55	9	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	4	....	....	....	....	....	....	....
Gammarid spp.	....	2	1	1	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....
Melita sp.	11	2	....	4	17	....	....	6	....	3	66	9	....	....	....	....	8	....	5	8	....	....	....	....	....	7	28	9	....	....	....
Pallasea sp. ?	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Talorchestia sp.	2	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Leander intermedius	1	....	....	....	....	....	....	10	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Cyclograpsus audouinii	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Halicarcinus australis	1	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Litarachna sp.	....	....	....	....	....	....	....	....	....	....	....	9	....	....	....	2	....	....	....	....	....	....	....	....	....	....	2	8	....	6	....
Chironomid larvae	....	1	....	....	2	....	3	4	4	....	....	....	....	....	1	....	....	5	....	....	....	....	1	1	....	....	....	3	....	....	....
Modiolus sp.	....	....	....	....	....	....	....	4	....	....	....	....	....	....	1	....	....	1	....	7	6	....	....	....	....	....	....	....	....	....	....
Lamellibranch sp.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....
Rissoa sp.	....	....	....	....	....	....	....	....	1	....	....	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....
Gastropod eggs	....	....	M	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Ascidea malaca	....	....	2	....	5	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Botryllus sp.	....	....	....	....	M	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Sagitta sp.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....
Fish eggs	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	1	....	....	....	....
Total Population	150	379	185	160	169	....	109	377	159	142	166	69	....	20	55	107	58	195	28	75	6	28	37	33	12	96	879	418	114	951	182
Species Density	16	12	13	17	17	....	5	22	11	14	19	13	....	1	8	6	3	21	11	12	1	3	5	6	2	11	8	25	6	10	3

M = Masses.

TABLE 2.

VARIATION IN POPULATION WITH DEPTH.

Species.	March.				July.		November.	
	Enteromorpha compressa.				*Cystophyllum muricatum*		*Ectocarpus confervoides.*	
	Open.		Sheltered.					
	Above 4 in.	4 in. to 1 ft. 6in.	1 ft. 6 in. to 2 ft. 6 in.	Above 4 in.	Above 1 ft.	Below 1 ft.	Above 1 ft.	Below 1 ft.
Leptoplana spp.	....	3	1	5	....	....	....	....
Nematoda spp.	32	8	10	....	....	12	....	....
Ceratonereis erythraeensis	....	19	4	5	....	....	2	2
Nereis oxypoda	....	....	....	....	....	....	3	3
Small Nereids	....	3	....	....	1	3	....	....
Odontosyllis fulgarans	....	....	....	....	....	2	....	....
Spionids	....	7	....	2	....	....	....	....
Ameira minor	....	16	....	8	....	....	....	....
Amphiascus sp.	....	10	....	9	....	....	....	....
Dactylopusia tisboides	....	9	....	2	....	4	....	....
Harpacticus gracilis	....	8	64	46	2	5	....	3
Mesochra parva	....	....	....	....	....	5	804	33
Parathalestris sp.	....	....	....	....	2	5	....	....
Tegastes sp.	....	....	1	....	....	....	....	....
Tisbe graciloides	....	....	....	5	....	....	....	....
Tisbe tenera	....	....	....	....	....	3	....	....
Zaus sp. ?	....	....	3	1	....	....	....	....
Gladioferens imparipes	....	....	....	....	....	3	....	298
Xestolebris aurantia	....	....	....	....	....	....	2	2
Cytherid sp.	....	....	....	1	....	....	3	2
Tanais cavolinii	20	33	169	18	3	39	....	1
Cruranthura simplicia	....	....	....	....	1	4	....	....
Munna brevicornis	....	....	....	....	....	....	....	2
Caprella spp.	43	23	4	84	15	47	....	....
Corophium minor	....	1	24	12	....	3	....	4
Erichthonius pugnax	....	....	....	....	....	9	....	....
Melita sp.	....	3	8	....	....	15	....	....
Chironomid larvae	....	2	....	1	....	2	1	....
Litarachna	....	....	....	....	....	....	6	....
Modiolus sp.	....	2	....	1	....	....	....	....
Halicarcinus australis	....	....	....	1	....	....	....	....
Ascidea malaca	....	....	....	....	....	6	....	....
Botryllus sp.	....	....	....	....	....	M	....	....
Total Population	95	147	284	201	24	167	821	350
Species Density	3	16	8	16	6	18	7	10

M = Masses.

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